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USEFULNESS OF THE AMERICAN TOAD.

BY

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UNITED STATES DEPARTMENT OF AGRICULTURE,
DIVISION OF ENTOMOLOGY,
Washington, D. C., April 22, 1904.

DEAR SIR: I submit herewith a short paper on The Usefulness of the American Toad, prepared by A. H. Kirkland, M. S., of Boston, Mass., an entomologist and writer on entomological subjects. Mr. Kirkland has made a somewhat thorough and extended study of the toad as a destroyer of insects, arriving at the conclusion that this little animal is a valuable friend to all who are engaged in agriculture, and supporting this conclusion with evidence derived from his investigations. In the hope that the toad's life history and habits may be better understood, its usefulness more fully appreciated, and its protection from wanton destruction secured, it is recommended that this paper be published as a Farmers' Bulletin.

Respectfully,

L. O. HOWARD,
Entomologist.

HON. JAMES WILSON,
Secretary of Agriculture.

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USEFULNESS OF THE AMERICAN TOAD.

INTRODUCTION.

The heavy tax levied by insects on nearly all agricultural crops is well known to farmers. Nearly as well known, thanks to Experiment Station experts and others, are the principal remedies for combating these pests. But in the long run nature provides the most efficient checks on insect increase and these often are but little understood or appreciated. While the value of birds as destroyers of noxious insects is now becoming generally recognized, the silent, inconspicuous work of insect parasites and certain predaceous animals receives but slight recognition even from those who are most directly benefited. Thus the common toad,[a] nocturnal, of quiet habit and appearance, renders notable service to farmers and gardeners throughout the entire growing season; yet to many its worth is unknown, while to others it is even an object of disgust, if not of fear. It must be admitted that to some the toad can never be an attractive animal. Nature has denied it the gay colors of bird life or even the sinuous beauty of some of its reptilian relatives. Yet, judged by the standard of good works, the toad does not suffer by comparison with any of the lower animals.

The toad has always borne the burden of false and even ludicrous misrepresentations. We have adopted in their entirety the principal European traditions concerning the toad as set forth by the early writers on natural history. These ancient savants, who did so much to establish the study of nature, had the failing, not confined to that age, of confounding fancy with fact. Thus the popular superstitions of that time are curiously interwoven with their statements concerning the life history and habits of the toad. The early writings on this subject teem with vague and ludicrous fancies of the toad's venomous qualities, its medicinal virtues, and more commonly of the valuable toadstone or jewel to be found in its head. All these traditions are to be met with even in this era of progress, and coupled with them we hear of the equally surprising ability of the toad to produce

[a] The information given in this bulletin relates chiefly to our common eastern toad (*Bufo lentiginosus americanus* Le C.). Other species have similar habits where the same classes of insects are available for food.—EDITOR.

warts on the hands; to poison infants by its breath; to bring good fortune to the house in whose new-made cellar it takes up its abode; and, finally, to cause bloody milk in cows if killed by accident or design. The writer well recalls the shock his credulity received when in the inquisitive stage of boyhood he faithfully tested several of these superstitions with only negative results. When so much that is false has been written about the toad it may not be amiss to increase the scanty literature of facts concerning this humble servant of man as determined by a somewhat intimate acquaintance extending over a decade or more.

LIFE HISTORY AND HABITS.

To the nature lover there are few more interesting subjects than the development and habits of the toad. In New England toads do not bestir themselves until April or May, but in more southern latitudes March finds them wakening from their winter's sleep and beginning their annual migration toward the breeding ponds, where a little later is heard the soft, drowsy, musical trilling of the males, so well described by Gibson as the "sweetest sound in nature." The number of toads which migrate even to a small pond is remarkable. The writer once counted 356 toads on the shores of a pond containing scarcely half an acre. Mating is commenced as soon as the water is reached, or even before. The tiny black eggs, with their gelatinous covering, are laid in long "ropes," the envelope swelling to a notable degree as soon as it comes in contact with the water, thus forming a mass many times larger than the body of the parent toad. In two weeks, or even sooner if the water be warm, the eggs hatch and the young tadpoles feed greedily upon the gelatinous envelope. Next the slimy deposits common to ponds are attacked. The tadpoles grow rapidly, until by June or July the legs develop, the tail is absorbed, and the young toads leave the pond which has sheltered them, never to return except for brief visits at the mating season.

The little toads are very sensitive to heat and secrete themselves under leaves, rubbish, stones, etc., during the day; but let a vigorous shower descend and frequently walks, roads, and gardens at once become peopled with these thirsty leaping creatures. So sudden is their appearance under these conditions as to lead to the popular belief that they rain down. The inability of toads to endure heat serves as an indirect protection for them at this stage. They are delectable morsels to many birds, and, were it not for the fact that they are obliged to seek shelter by day, large numbers would be destroyed. As it is, many are devoured by the predaceous birds and mammals which prowl at night.

It seems probable that the toad does not begin to reproduce until the fourth year. The number of eggs laid by a full-grown female

toad is remarkable. It is a rule of nature that where the chance for a species reaching maturity is small the fecundity is large, and this rule is well illustrated in the case of the animal under discussion. The writer once removed 1,279 eggs from a female toad which had already commeneed laying. The total egg production is better indicated by the record of 7,587 and 11,545 eggs obtained from two toads by Dr. C. F. Hodge, Clark University, Woreester, Mass., as recorded in his book entitled "Nature Study and Life."

Many stories are extant concerning the longevity of the toad. These animals are said to have been found embedded in rocks, trees, masonry, etc., thus indicating that it was possible for them to exist in dormant condition for many years. The writer has gone to some trouble to investigate statements of this kind eoming to his attention without finding a single case where there was conclusive evidence of such a prolonged dormant state. On the other hand, we have the experiment of M. Herrisant, who in 1777 embedded three toads in plaster and placed them in the archives of the Freneh Academy of Sciences. At the end of eighteen months two of the toads were still alive. In 1817 Doetor Edwards repeated this experiment, but submerged the plaster bloeks in water, with the result that all of the toads died. Buckland buried toads in cavities in sandstone and limestone and found that all the toads in sandstone were dead in thirteen months, while those in limestone survived for nearly two years.

The toad has a strong "homing" instinct, and lives year after year in the same locality. Convincing evidence has been furnished the writer of two toads that have oeeupied dooryards in two different towns for twelve and twenty-three years, respectively, while Mr. F. H. Mosher, Westport, Mass., has positive knowledge of a toad which occupied a certain feeding ground for at least eight years. In view of these facts, there can be little doubt that the toad attains to a eonsiderable age.

The belief that the toad is venomous probably arises from its habit, when disturbed or roughly handled, of ejecting through the skin a certain milky acrid fluid. No harm attends contact with the fluid on the hands, but dogs attempting to bite toads show signs of diseomfort, and even distress, due to this acrid skin secretion. That the fluid is not objectionable to all animals is shown by the avidity with which certain hawks and owls capture and eat toads.

It is not uncommon to find during the summer certain toads of much brighter colors than their fellows. This is due to the casting or molting of the skin, which takes place several times annually. Previous to molting, the toad seeks shelter and remains quiet for some time. The skin then splits, peels off, or is removed by aid of the forelegs, and is often eaten by the toad, which soon goes forth clad in fresher colors.

Though living alone through the summer, it is not an uncommon thing to find a dozen or more toads hibernating in a colony under some convenient rock or board. Winter quarters are sought quite early in the fall beneath rocks, leaves, or rubbish, or in other places where the action of the frost will not be severely felt. Figuier states that these animals freeze without being killed, and it is not unusual to find toads in winter apparently frozen stiff some distance below the surface of the soil.

FEEDING HABITS.

Soon after sundown, or even before on cool evenings, the toad emerges from its shelter and sallies forth in search of food. In country districts it nightly patrols over roadsides, gardens, cultivated and new-mown fields—in short, all places where insect life abounds and long grass or herbage does not obstruct its travel. In cities and villages the spots beneath electric lights are particularly favored, while lawns and walks also receive attention. The toad has learned that electric and other lights attract large numbers of flying insects, many of which fall injured to the ground below. At Amherst, Mass., the writer once observed eight well-fed toads holding festival beneath an arc light. During the flying season of the brown-tail moth in Massachusetts there is no more common night scene than that of the toads devouring the white moths which fall fluttering from the lamps above.

For two successive summers the writer had opportunity to make numerous observations on toads feeding under natural conditions at all hours of the night. From these observations and from stomach examinations it was apparent that the toad feeds continuously throughout the night, except when its food supply is unusually abundant, when periods of feeding and resting alternate. From such observations, as well as by studying toads confined in cages, it was found that in twenty-four hours the toad consumed a quantity of insect food equal to about four times its stomach capacity. In other words, the toad's stomach is practically filled and emptied four times in each twenty-four hours.

Dead or motionless food has little attraction for the toad. Only living and moving insects, centipedes, etc., are devoured. Cutworms, for example, are safe while they remain curled up, but let them commence crawling and they are soon snapped up by the toad. At first thought it strikes one as odd that the toad's tongue is attached in front and free behind, particularly as the tongue is its only means for capturing food. However, one needs only to watch the feeding of a toad for a few minutes to satisfy himself that this organ is well adapted to its work. The tongue is coated with a glutinous secretion and adheres firmly to the food it seizes. When the writer first took up the study

of the toad he confined a large specimen in a well-shaded box out of doors. So ravenous was its appetite that to provide sufficient insect food was quite a task until a satisfactory expedient suggested itself. When a hard bread crust was soaked in molasses and placed in the cage it attracted a sufficient number of flies, bees, ants, beetles, etc., to keep the toad well supplied with food. The toad would sit motionless beside the bread crust until a moving insect came within range, when its tongue would be thrown out with lightning-like rapidity and the insect, often on the wing, would suddenly disappear within the toad. The diet of this toad was varied with occasional fish worms, which, being too large to swallow at once, were forced down the gullet by means of the fore limbs.

THE FOOD OF THE TOAD.

As pointed out previously, the toad is of direct service to man by reason of the noxious insects which it destroys. Should it feed on beneficial insects, it would be to that extent an injurious animal. There is only one way to determine accurately to what extent an insectivorous animal is beneficial or injurious, and that is by a careful examination of the contents of a sufficiently large number of stomachs collected at different dates and over a suitable range of territory. While field observations furnish important circumstantial evidence and aid to an understanding of the kind and condition of food found, the stomach examinations, as Prof. F. E. L. Beal has so aptly put it, "constitute the court of final appeal." Patience, strategy, and good eyesight will enable one to study the feeding habits of such animals, but the absolute identification of the kind and quantity of their food can not be made at long range. For accurate results the material devoured must be available for careful analysis, often under a microscope.

The writer a few years ago collected and examined 149 toads' stomachs, particular effort being made to secure representatives from different sections and from a wide range of places, i. e., gardens, fields, hills, woodlands, city streets, etc., during every month of the feeding season. This number is doubtless too small to show the exact status of the toad in the region covered, yet it is sufficient to afford interesting data for some general conclusions. With the exception of a few stomachs preserved in formalin, all were examined while fresh, the stomachs being split along the outer curvature and the contents carefully washed into a glass dish. The material thus obtained was separated into its proper groups, identified, and its percentage of the entire bulk estimated and noted. The number of stomachs examined, by months, was as follows: April, 7; May, 30; June, 66; July, 29; August, 10; September, 7; total, 149.

Stomach contents of 149 toads, with percentage, by bulk, of each food element.

Food elements.	Part, by bulk.	Food elements.	Part, by bulk.
	Per cent.		*Per cent.*
Ants	19	Spiders	2
Cutworms	16	Sow-bugs	2
Thousand-legged worms	10	Potato beetles and allies	1
Tent caterpillars	9	Carrion beetles	1
Ground beetles and allies	8	Miscellaneous beetles	1
May beetles and allies	6	Snails	1
Wireworm beetles and allies	5	Angleworms	1
Weevils	5	Vegetable detritus	1
Miscellaneous caterpillars	3	Gravel	1
Grasshoppers, crickets	3	Unidentified animal matter	5

This table shows that at least 98 per cent of the toad's food is of animal origin. The vegetable matter (1 per cent) was composed of bits of grass, leaves, rotten wood, etc., evidently swept in by accident along with the insect food. It is in this way, doubtless, that gravel (1 per cent) found its way into the stomachs. The unidentified material consisted of broken parts of insects, animal tissue, etc., which were so finely ground as to be beyond recognition and probably represented injurious species in great part, although not so considered in the table.

The nature of the vegetable and mineral matter found in the stomachs needs no further mention. The animal matter recognized constitutes 93 per cent of the total food, of which 77 per cent was insects and 16 per cent other forms. As might be expected, nearly all the animal matter is composed of terrestrial species or of forms which at some time frequent the ground for shelter or migration.

Worms.—The common angleworm was present in 14 stomachs, principally in toads taken soon after showers, and formed 1 per cent of the total food. Rains drive the worms to the surface, where they fall easy victims to a particularly hungry toad. From studying toads in confinement, it appears that worms are not preferred by that animal as an article of diet, but may be eaten. Worms are of great service in tilling and aerating the soil, as Darwin has so well shown. On the other hand, they often cause great annoyance in greenhouses and in flower beds out of doors. Since the toad frequents the abodes of man, it seems probable that the good done by worms in such localities may well be offset by their damage as above mentioned.

Snails.—Snails are a serious pest in greenhouses and gardens, where their depredations on lettuce and other succulent plants are well known. Several of the large naked snails common in gardens were found in the stomachs, while, in the case of the shell-bearing snails, it was found that the acid stomach juices of the toad were sufficient to dissolve the shell in a short time. It seems a little strange that such slow-moving animals should attract the attention of the toad, yet it is apparent that the animal finds them suitable articles of food, as shown by their constituting 1 per cent of the total stomach contents.

Sow bugs.—These small creatures were most numerous in stomachs taken in the late summer, and made up 2 per cent of the food for the season. Their damage to the roots of orchids, violets, pansies, roses, etc., has been frequently noted by florists. By destroying them the toad renders a distinct service.

Thousand-legged worms.—These form a constant article of diet, as many as 77 having been found in a stomach. Ten per cent of the food of the toad was of this class. They are frequently called "wire-worms," although this name belongs properly to the young of the "click beetles." Farmers often find the attacks of these myriapods on potatoes a serious matter. The late Dr. J. A. Lintner has recorded an instance where for two years in succession a potato crop was severely injured by these "worms." Many cases of injury to newly planted potatoes have come to the writer's attention, while others have recorded the partial destruction of cucumbers, tomatoes, etc., from this cause.

Spiders.—It is not strange that such active creatures as spiders form 2 per cent of the toad's food. Naturally most of the spiders were of terrestrial species. How much good spiders accomplish is an open question, but since they destroy large numbers of flies we have included them in the column of beneficial insects. It should be noted, however, that the spider's web often catches those active parasitic flies which would otherwise serve man through the destruction of injurious caterpillars. Perhaps a fair statement would be that the harm the toad may do by including 2 per cent of spiders in its menu is offset by the 13 per cent of snails, sow bugs, and "thousand legs" which it destroys. This brings us, then, with a clean balance sheet to a consideration of its insect food in the strict sense of the term.

Grasshoppers, crickets, etc.—These insects were found to make up 3 per cent of the food of the toad, and included several of the common species of the hay field as well as house crickets, tree crickets, and cockroaches. The damage to grass and grain crops by grasshoppers is too well known to require more than mere mention. The black house cricket is often a nuisance, while the cockroaches and water bugs are even worse. The small roach or water bug was often found in stomachs of toads taken on city streets. The toad is entitled to unstinted praise for its work in destroying these insects.

Ants.—We come on debatable ground when we take up the economic importance of ants. The writer for the purposes of this paper has regarded them as of neutral value. Most entomological writers regard lightly the shortcomings of these industrious and highly intelligent creatures. Certainly one can not observe their systematic domestic arrangements and evident reasoning powers without a feeling of sincere admiration. During the season of their activities they destroy a certain number of soft-bodied insects and carry off more dead ones as a

provision against future need. On the other hand, they care for and distribute plant lice and certain other related insects, infest lawns, walks, and dwellings, attack cooked food, and often make of themselves an unmitigated nuisance, as many a perplexed housekeeper can attest.

Ants constituted 19 per cent of the total contents of the stomachs examined. The greatest number was found in the May examinations, when they were present in 70 per cent of the stomachs and formed 23 per cent of the food for that month. Aside from ants a few allied insects—such as bumble bees, honey bees, wasps, and hornets—and two ichneumon flies were noted in the examinations. The latter insects are beneficial as parasites on certain caterpillars. Beekeepers have informed the writer of cases where toads had taken position at the entrance of hives, and thus destroyed a large number of bees. This loss might have been avoided by raising the hives above the surface of the ground. Since the toads feed principally at night, such cases are probably of rare occurrence.

Beetles.—There is a certain family of active black or metallic ground beetles, which are usually present in gardens, fields, or woodlands, feeding for the most part on soft-bodied insects, and occasionally varying their diet by attacking low-growing fruits. These ground beetles undoubtedly are beneficial, as a whole, although the damage to strawberries by certain species has caused considerable loss at times. The most serious charge to be laid against the toad is the destruction of these ground beetles, which make up 8 per cent of the total food.

On the other hand, the members of the May-beetle and click-beetle families are commonly present, and furnish 6 and 5 per cent, respectively. The May beetle, or June bug, is unfavorably known as the parent of the white grub, which, in certain years, destroys large areas of grass land and lawns, and also works havoc on the potato crop. Promiscuous shooting of crows has removed one of the principal checks on this insect; hence the service of the toad in this connection is of especial value. The "rose bug," or rose-chafer, was found in several stomachs.

The common wireworms, which attack newly planted corn, are the progeny of the click-beetles, and these insects were present in large numbers in the stomachs examined. Wireworms also attack potatoes, lettuce, cabbage, and other garden crops.

Snout-beetles, or weevils, make up 5 per cent of the toad's food. These insects, of which the plum curculio is a good type, are among the most difficult pests to combat. Nearly all have the habit of dropping to the ground and feigning death when disturbed, thus giving the toad a chance to capture them. Among the species found in the stomachs were two specimens of the plum curculio, and many which bore in standing timber and shade trees.

Potato bugs, cucumber beetles, and their allies amounted to 1 per

cent of the total food. The injurious habits of these species need no comment. Of equal rank were the carrion beetles (1 per cent) of possibly beneficial habits, and miscellaneous beetles (1 per cent). The latter, aside from an occasional ladybug (beneficial), are of no special importance. The sole value of the carrion beetles lies in their habit of burying or devouring dead animal matter which might otherwise become offensive.

Cutworms and army worms.—The young or larvæ of moths formed 28 per cent of the total food; cutworms forming 16 per cent, tent caterpillars 9 per cent, and miscellaneous caterpillars 3 per cent. The destruction of cutworms is of special importance. These insects feed by night, and the grower only learns of their presence through the loss of his lettuce, cabbage, and other plants. Hand labor offers the most practical remedy, and this is ably assisted by the efforts of the toad. To appreciate fully the number of cutworms a full-grown toad may consume, one should watch these animals in a field infested by army worms, which are members of the cutworm family. Three toads taken under such conditions contained, respectively, 9, 11, and 55 army worms. These soft-bodied insects are quickly digested, and the toad's capacity for cutworms seems only limited by the supply.

Tent caterpillars.—The insects consumed by the toad are chiefly those of terrestrial habit. Yet the good work of the toad is not confined to insects of this class. There are a large number of caterpillars which feed ordinarily on trees, yet seek the ground when ready to transform, and these fall easy victims to the toad. The common tent caterpillar of the wild cherry and apple well illustrates this point. These caterpillars when full grown often travel considerable distances in search of suitable places for cocoon making.

In May these insects formed 18 per cent of the food, and for the season 9 per cent. This insect is a pest of the first rank on apple trees and occasionally works on cherry, plum, and peach. It is much preyed upon by the cuckoo and oriole, while the toad secures a fair proportion of those that escape the birds. From 15 to 20 were often found in the stomachs, 37 being the largest number noted. The writer once saw a black-billed cuckoo eat 35 of these insects at one meal. That bird is well protected by wise laws. The toad has equally as good a record, but receives no legal protection from wanton cruelty.

Miscellaneous caterpillars.—Among these insects, which formed 3 per cent of the food, were noted such injurious species as the gypsy moth, canker-worm, Vanessa, grape and celery caterpillars, tomato worms, cabbage worms, etc. An abundance of active gypsy-moth caterpillars in certain Massachusetts localities often proves sufficient to tempt the toad from retirement even at midday. Three of the toads' stomachs examined contained, respectively, 7, 15, and 65 gypsy caterpillars. As a means of checking the increase of such a serious pest the value of

the toad is small, but the case is of interest as showing that tree-infesting caterpillars are often captured by this animal.

It would seem that such heavily armored insects as the spiny Vanessa caterpillars would escape the toad, yet in spite of their natural protection they are gathered in without apparent discomfort. The damage caused to the elm, willow, and apple by these insects is a matter of common knowledge.

Elsewhere mention has been made of the capture by the toad of the winged brown-tail moths as they fall partially stunned from the street lamps. The lamps have a strong attraction for the moths, and the toad makes sure that few if any escape. This imported European pest has now become well established in several New England States, particularly in residential districts. It is here that the toad is most valuable as a destroyer of the moths. Four toads taken under electric lamps contained 10, 11, 15, and 17 moths, respectively. The caterpillars of this insect are but little more fortunate than the moths. Six toads taken in infested orchards contained, respectively, 3, 3, 5, 7, 8, and 12 caterpillars. When we consider that the hair with which these insects are clothed produces a most intense irritation whenever it comes in contact with the human flesh, it would seem that the toad is practically immune from injuries of this class, and that few if any caterpillars are well enough protected to escape its rapacious appetite once they come within its reach.

ECONOMIC STATUS OF INSECTS DESTROYED BY THE TOAD.

In the following table an attempt is made to strike a balance between the good accomplished by the toad through its ravages on injurious species and the harm it does by destroying beneficial species:

Insect food of the toad classified as regards economic status.

	Beneficial.	Neutral.	Injurious.
	Per cent.	*Per cent.*	*Per cent.*
Cutworms, caterpillars, etc			28
Ants		19	
Injurious beetles			18
Sow bugs, myriapods, snails, etc			13
Ground beetles	8		
Grasshoppers, etc			3
Spiders	2		
Carrion beetles	1		
Worms		1	
Vegetable matter		1	
Mineral matter		1	
Total[a]	11	22	62

[a] The 5 per cent unidentified has been excluded from this classification.

To summarize: Against the toad must be reckoned the destruction of many beneficial ground beetles, a few spiders, an occasional carrion beetle, ladybird, and ichneumon fly, forming as a whole 11 per cent of its food.

To the credit of the toad we must place the destruction of a remarkably large number of particularly injurious insects, such as cutworms, army worms, caterpillars, gypsy moths, brown-tail moths, May beetles, rose-chafers, wireworms, cucumber and potato beetles; also snails, thousand-legged worms, and sow bugs. The quantity of injurious species destroyed forms 62 per cent of its total food. Should ants be included as injurious, as many housekeepers would think proper, this figure would be increased to 81 per cent. These figures, derived from careful examinations, show the toad to be a highly beneficial animal and well entitled to man's protection in every possible way.

THE TOAD'S CAPACITY FOR GOOD.

The amount of food consumed by the toad is remarkable. Elsewhere records have been given of finding 77 thousand-legged worms in one stomach, 37 tent caterpillars in another, 65 gypsy moth caterpillars in a third, and 55 army worms in a fourth. Under the writer's direction, 24 medium-sized gypsy moth caterpillars were fed to a toad under observation before its appetite was appeased, while Mr. F. H. Mosher fed over 30 full-grown celery caterpillars to another in less than three hours. Doctor Hodge has seen a toad "snap up 86 house flies in less than ten minutes," while he has also published an interesting observation by Ellen M. Foskett, Worcester, Mass., who fed 90 rose bugs to a toad without satisfying its appetite.

The number of insects a toad consumes in a season is conjectural. The writer is satisfied that the amount of food taken in twenty-four hours amounts to about four times the stomach capacity. In cold weather this figure would be lower, while in midsummer, when insect life is at its height, the quantity would probably be larger. A typical stomach examination as taken from the writer's notes is given below.

Specimen 43, taken 9 p. m. May 11, 1896:

	Per cent by bulk.
6 cutworms	50
5 thousand-legged worms	20
6 sow bugs	20
9 ants	6
1 weevil	2
1 ground beetle	2

On the basis of the above data the amount of food consumed in certain periods would stand as follows:

Numbers of insects which one toad may destroy.

Period.	Cutworms.	Myriapods.	Sow bugs.	Ants.	Weevils.	Ground beetles.
24 hours	24	20	24	36	4	4
30 days	720	600	720	1,080	120	120
90 days	2,160	1,800	2,160	3,240	360	360

In ninety days (a period selected because May, June, and July represent the time of the toad's greatest activity) it would destroy 360 beneficial insects (ground beetles) and 9,720 injurious or noxious insects. Take the single item of cutworms. These insects are preyed upon by ground beetles. Let us assume that the ground beetles, if spared, would have succeeded in capturing 10 per cent of the cutworms. This would leave a net balance of 1,944 cutworms to the toad's credit. Many gardeners give their children one cent apiece for each cutworm found and destroyed, considering this a low estimate of the damage caused by the insects. Even at this nominal figure, without considering the importance of the destruction of other injurious insects, the toad's services on this one item would figure $19.44.

NATURAL ENEMIES OF THE TOAD.

The toad suffers from enemies both natural and unnatural. Of those provided by Nature a few internal parasites are sometimes found, while hawks, owls, crows, snakes, and skunks yearly destroy large numbers. The marsh hawk kills a great many toads during the spawning season, while hens, ducks, geese, and guinea fowls feed on the young toads as they migrate from the breeding pools.

It is perhaps the irony of fate that large numbers of the toad should be killed annually by man, the one most benefited by its life. Lawn mowers work great slaughter among them, while the practice of burning over lawns and fields kills more. The killing of toads in this way is largely unnecessary and the extra labor involved in protecting their lives will be more than repaid by their services.

The heaviest charge of wrongdoing must be entered against the small boy, ubiquitous, inquisitive, and often thoughtlessly cruel. In a case coming under the writer's notice two boys in one afternoon established the disreputable record of 17 dead and mutilated toads captured at a breeding pool. Such a wanton and expensive exhibition of cruelty may be unique, but it is certain that thousands of toads are killed in this way annually, and this practice will continue until our boys are taught to recognize the value of the toad and to respect its rights. Laws protect our insectivorous birds as well as others whose worth to man is, to say the least, a debatable question. The toad's worth is an established fact. Should it not receive a similar protection?

HOW THE TOAD MAY BE MADE USEFUL.

Elsewhere reference has been made to the strong homing instinct of the toad. This makes it difficult to establish toad colonies unless the animals are brought from a considerable distance. It is said that English gardeners often pay as high as $25 per hundred for toads for colonizing purposes. That such a procedure is sometimes successful

is shown by the experience of the well-known authoress, Celia Thaxter, who at one time found her beautiful gardens at the Isles of Shoals overrun by insects and snails. A considerable number of toads were imported from the mainland, with the result that in a short time the pests were suppressed and the flowers preserved from harm.

A better plan is to provide a breeding place for toads and carry them to it at the mating time, so that later in the season the young toads leaving the water may establish themselves in the locality. A shallow pool having a small but constant water supply is all that is needed. Stagnant rather than running water is desirable, since the growths in which the tadpoles feed do not develop so well where there is a current. Further, the stagnant pools usually have a higher temperature, thus favoring the growth of the tadpoles. Against this plan may be urged the breeding of mosquitoes in such pools, and under some circumstances this objection may prove an important one. It is entirely possible, however, that the tadpoles would keep down the mosquito larvæ, and in any case the young toads will leave the water by midsummer or before the mosquitoes become abundant, when the pools may be drained.

It is always well to provide artificial shelters for toads in gardens. These are easily made by digging shallow holes and partially covering them with a board or flat stone. Toads will use these shelters for weeks, sallying forth by night and returning at daybreak. Greenhouse owners will find toads particularly useful as destroyers of snails, sow bugs, weevils, and other injurious forms of animal life. The well-known entomologist, Dr. Ritzema Bos, writes: "In the research garden of the Rouen entomological laboratory the snails were entirely exterminated in 1891 as a result of introducing 100 toads and 90 frogs." At Malden, Mass., a collection of valuable orchids were severely injured through the attacks of myriapods and sow bugs. On the writer's advice a number of toads were introduced and all damage from this cause soon ceased. Many other cases where the toad may be made useful will suggest themselves. The common greenhouse rose weevil (Fuller's beetle) can doubtless be controlled in greenhouses by aid of toads, particularly if the beetles be jarred from the bushes at occasional intervals.

THE STUDY OF THE TOAD.

"Go to the ant, thou sluggard," was Solomon's dictum. One may find profit and pleasure in studying any of the common forms of animal life, but few offer a more attractive field than the subject of this paper. Abundant everywhere, harmless, easy to obtain and rear, the toad is one of the best objects for class-room work in nature study. A small aquarium and a pair of toads or a mass of toad's eggs are all that are required. Let the aquarium be of glass, earthenware, or

wood, shallow, and supplied with plenty of water plants, a few fresh-water clams or mussels to keep the water in circulation, and a small quantity of dog biscuit or chopped fresh meat if needed when the tadpoles are half grown. Care must be taken not to supply more meat than they will devour, since otherwise the water may become fouled. Such an aquarium makes an object of unfailing interest in the school-room or home, and by summer will yield hundreds of small toads for colonizing gardens and farms. The value of such a study to the children can not be overestimated.

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